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Review

A multidisciplinary approach to post-bariatric plastic surgery

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ABSTRACT

Social changes over the last 100 years, but predominantly since the invention of 'fast food' have led to an explosion in obesity. The National Institute for Clinical Excellence advise referral of patients with body mass indices >40 for bariatric surgery. One third of post-bariatric surgery patients achieve massive weight loss necessitating reconstructive body contour surgery.

This unique group of patients presents multiple challenges for medical and ancillary practitioners involved in their care. A multidisciplinary approach is essential.

1. Introduction

This paper aims to clarify the multidisciplinary intercalated issues surrounding the emerging sub-specialty of plastic surgery: body contouring following massive weight loss. We highlight the challenges presented by this rapidly growing group of patients, increasingly referred to us and our colleagues.

Social changes over the last 100 years, but predominantly since the invention of 'fast food' have led to an explosion in obesity. An altered attitude to exercise amongst the youth of our communities has compounded this. 66% of the United States population currently has a Body mass index (BMI) of greater than 30 kg/m^2. The UK looks likely to follow this obesity trend and early data show geographically heterogeneous distribution of obesity across the country that may need to be reflected in future service provision (see Fig. 1).[1]

The future looks bleak as 17% of children already fall into the overweight or obese categories. Although dietary changes in combination with exercise are essential to breaking the weight gain cycle, patients have often surpassed a threshold above which, adherence to a standard weight loss regimen is extremely difficult and bariatric surgery is advised.

The National Institute for Clinical Excellence recently advised general practitioners to refer their patients with a body mass index (BMI) of over 40 (or those patients with a BMI > 35 with any significant comorbidity), for bariatric surgery. This is advisable only if they have failed to maintain weight loss using other non-surgical measures or by medically correcting the possible causes. The vast majority of patients have no underlying pathology and investigations rarely uncover physiological anomalies.

Care for these patients has become organised into multidisciplinary teams (MDTs). The aim of care is to improve or eliminate the pathophysiological and social burden of being obese. The MDT can facilitate the entire process that starts with proper patient selection for bariatric surgery. The usual members include general surgeons with an upper gastrointestinal tract and endoscopic interest, endocrinologists, dieticians, nurse specialists, and psychiatrists. It is illogical that Plastic Surgeons have not routinely been involved in this structure considering that patients progress to reconstructive surgery to remove hanging excess tissue after the weight loss.[3] Plastic Surgeons expressing an interest in this surgery need to understand the complexities of caring for this population. There are many medical, psychiatric and surgical issues about these patients, that Plastic Surgeons must become acquainted with.

The results of bariatric surgery have been encouraging[4] and can be classified into physiological, psychological and social, with improvements in overall human activity and productivity. Bariatric surgery is the most effective treatment for severe obesity.[5] Bariatric surgery is not without its risks and side effects including the complications of general anaesthesia, the surgical trauma, medium and longer-term nutritional deficiency, excess hanging flabby tissue, and psychological sequelae. Plastic Surgeons providing the

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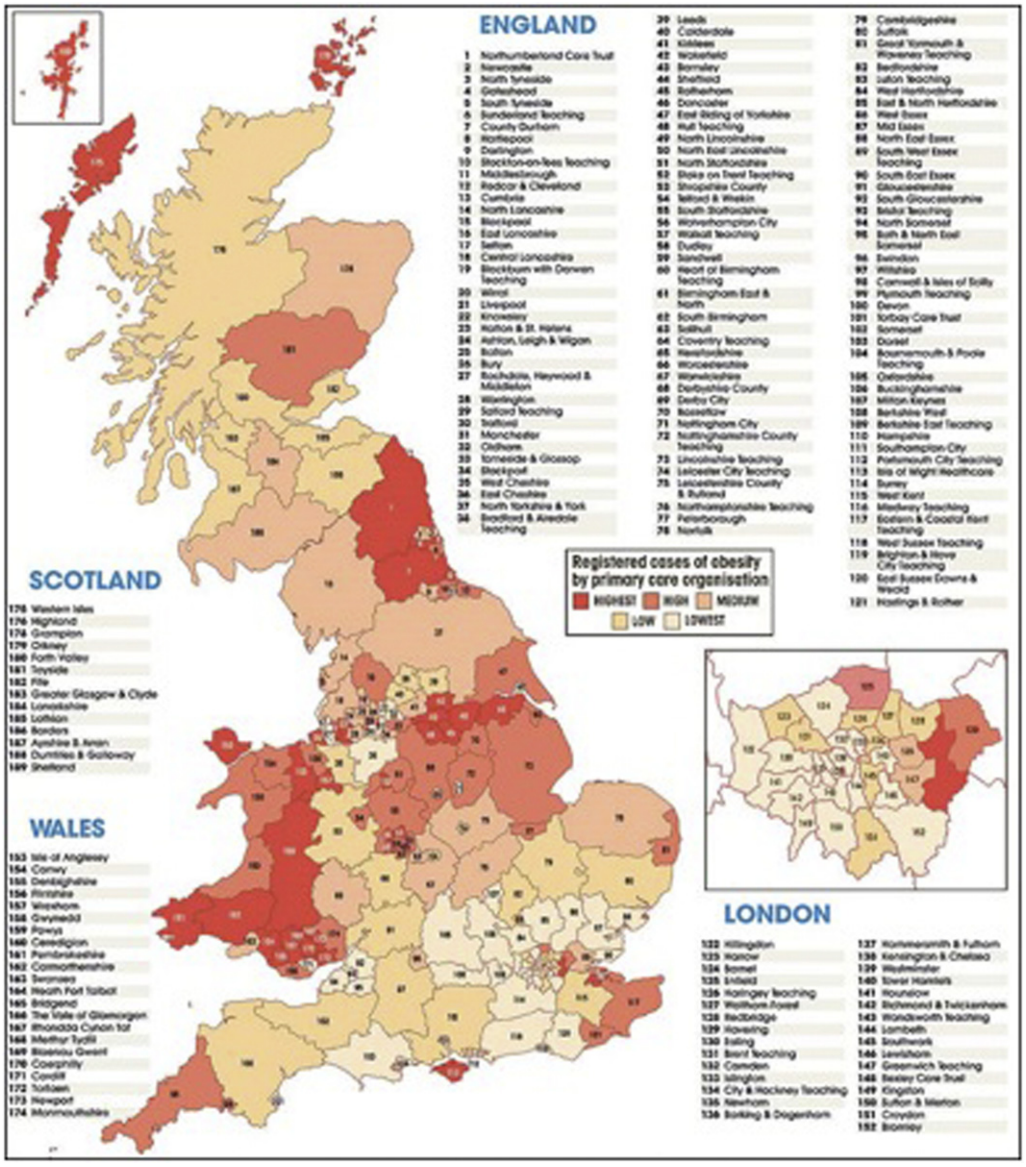

Fig. 1. Distribution of cases of obesity across the United Kingdom by county.[2]

reconstructive service after weight loss are looking after the same person, with diabetes and hypertension controlled, but with the added risks of nutritional deficiency interfering with wound healing. Pre-requisites, before reconstructive surgery can begin, include stable weight, optimisation of nutrition, and a fully informed patient with adequate social support.

Weight loss is predominantly from the fat stores found between the skin and musculoskeletal frame. The adipocutaneous envelope consists of a deep layer and a superficial layer of fat separated by the superficial fascia, and covered by the skin. Younger patients with better skin tone will exhibit natural soft tissue retraction that causes the adipocutaneous envelope to snugly enshroud their frame. Unfortunately approximately one third of patients are not so fortunate and their old adipocutaneous tissue envelope does not retract well, resulting in hanging excess skin. This is heavy, uncomfortable, interferes with mobility and clothing, and predisposes to infection and dependent lymphoedema. This 'deflation' of tissues is analogous to an old balloon that has lost its elasticity. The amount of weight loss, the speed of weight reduction, age of the patient and genetic predisposing factors all affect tissue retraction. Having undergone bariatric surgery with often-dramatic weight loss, and associated reductions in much comorbidity, patients are often still unhappy with their bodies. These patients are highly motivated to undergo body contouring surgery.

The surgeon planning these operations must have access to the bariatric MDT, where a comprehensive history of medical and psychological information has been built up over a prolonged period of time. The Plastic Surgeon needs to know about the medical and psychological issues prior to their involvement if he/she is to optimally manage each individual. These patients intercalated issues can be complex and the full support of the MDT is often needed for optimal care of these individuals through the body contouring process (see Fig. 2), particularly when wound healing or psychological complications arise. We have frequently found nutritional deficiencies in these pre-operative patients. This needs addressing by the specialist dieticians used to managing nutritional optimisation within the restricted confines of a bariatric diet. Patients can gain weight during their reconstructive programme

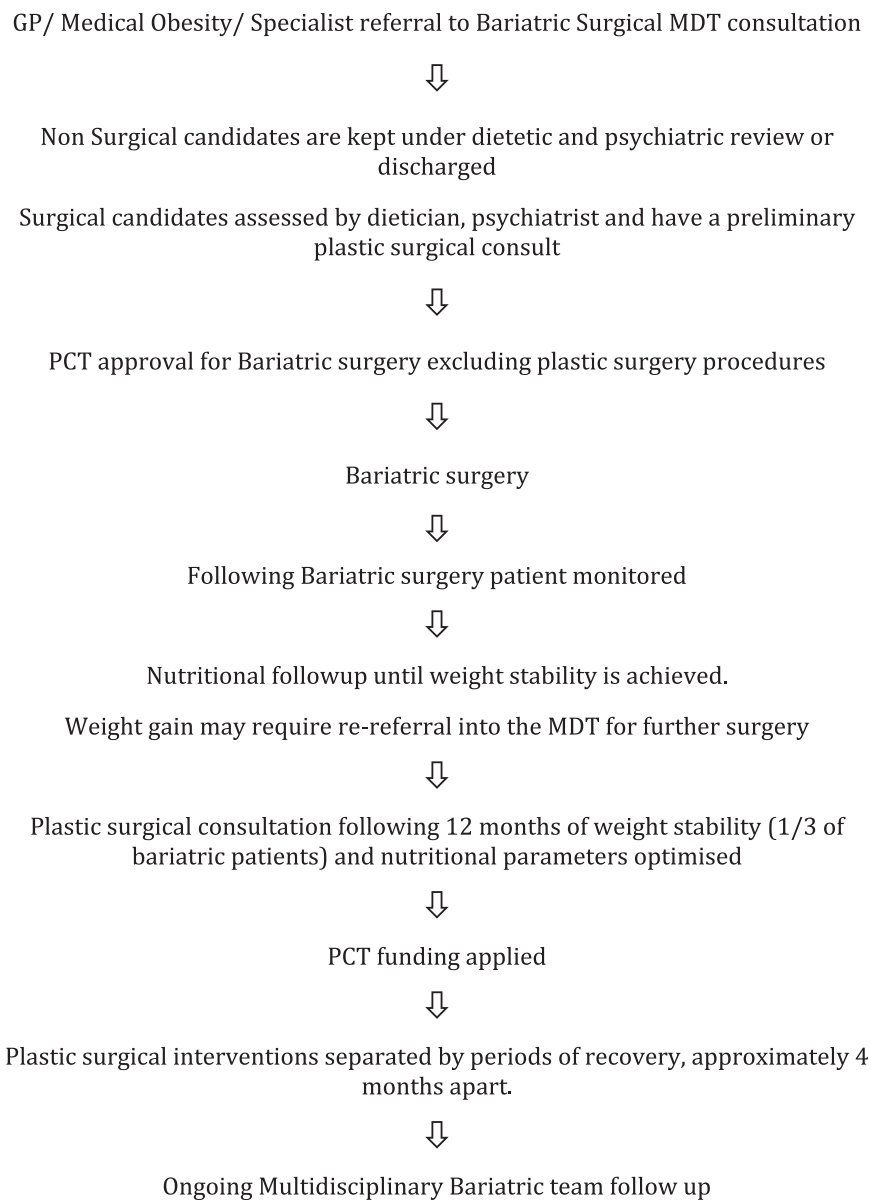

Fig. 2. Algorithm for patient referral through the bariatric MDT.

necessitating bariatric reassessment and intervention. Others can be psychologically fragile and need ongoing psychiatric input.

Socially, surgical intervention for weight gain and plastic surgery after massive weight loss has become more acceptable. Publicity has certainly had a major role to play in raising awareness. Patients tend to be more informed and show enthusiasm for restoration of body contour despite the amount of scarring and the risks incurred. Their excitement is tempered only by the social stigma of inappropriate vanity and feelings of failure, after having opted for 'a quick fix' approach to weight loss. This must be addressed if a truly holistic approach is to be undertaken.

Looking to the future, this growing population of patients may prove to be a significant burden on our National Health Service. Apart from the difficult to measure social issues, where will all the theatre time come from? If a bariatric procedure takes two to 3 h, the associated combination plastic surgery thereafter can cumulatively utilise over 10 operating hours and at least 7 nights cumulative hospital stay. There are long-term implications for National Health Service provision and logistical problems. The current lack of resources has led to differential access to what should be a streamlined multidisciplinary patient pathway, creating another postcode lottery.

The debate as to whether this type of surgery is reconstructive, similar to breast cancer reconstruction following oncological resection, or aesthetic and therefore inappropriate for NHS funding is outside the scope of this paper, but clearly should be debated within the forecast of restrained and even reduced public spending in the current economic downturn.

2. Bariatric surgery

The selection criteria for restrictive surgery versus malabsorbative procedures are complex. One should be aware that approximately 25% of gastric banding patients fail to lose 5% of their weight, some necessitating further surgical intervention, usually with a malabsorbative operation; 9% of these then fail to lose any significant weight.[6]

Evolving surgical techniques have resulted in progressive improvements in the safety and long-term integrity of bariatric surgical procedures. Previous reports of staple line failures of 15% or more in ten years[7] has resulted in increasing use of gastric resection, a technique that has almost universally been adopted by proponents of the laparoscopic approach to gastric bypass. In consequence, the need for revisional surgery to correct complications has decreased considerably.

Bariatric surgery improves several comorbid conditions such as glucose intolerance and diabetes mellitus,[8] sleep apnoea and obesity associated hypoventilation,[9] hypertension,[10] and serum lipid abnormalities. Studies have shown that Type II diabetics treated medically have a mortality rate three times that of a comparable group who undergo gastric bypass surgery.[11] Preliminary data indicates improved heart function with decreased ventricular wall thickness and decreased chamber size with sustained weight loss. Other benefits observed in some patients after surgical treatment include improved mobility and stamina. This leads to better mood, self-esteem, interpersonal effectiveness, and an enhanced quality of life. Patients are able to explore social activities previously inaccessible to them, enhancing social integration and productivity. Similarly, data in patients over 55 years of age at the time of bariatric surgery, followed for at least 6 years after gastric bypass, had significant sustained improvement in morbidity.[12] In fact, data from medical weight reduction studies suggest that even a moderate weight loss will favourably affect comorbidities.[13]

Like with any surgery, patients are at risk of incisional herniae and delayed adhesional obstruction. More specifically, bariatric surgery risks complications such as gastric band erosion, slippage or loosening in addition to anastomotic strictures, gallstones, nephrolithiasis, internal volvulus and liver failure. Plastic Surgeons need exposure to these conditions regularly in order to recognise these problems in their peri-operative patients. The best way to do so is within the MDT setting.

In a retrospective look at St George's data over the last 5 years, approximately 1/3rd of patients (25–33%) who successfully lost weight with bariatric surgery needed plastic surgical body contouring.

3. Nutrition

Nutrition is critical to good wound healing. The first year following bariatric surgery is the most important. Patients rapidly lose weight (which can be as much as 1.5 kg (or 1.5% weight) loss per week) and are acutely at risk of dehydration, iron deficiency anaemia and gallstones. This is particularly the case in the first three months. Gastrointestinal symptoms such as nausea and vomiting are commonplace as a consequence of ingesting food and/or liquids too rapidly. Intestinal re-routing procedures risk bowel obstruction, which should be excluded before starting antiemetics, traditionally efficacious against these usually temporary complaints. Rapid transit of food into the small bowel[14] can cause symptoms of nausea and vomiting, accompanied by tachycardia and palpitations in a 'dumping' syndrome, which can later manifest itself with diarrhoea and abdominal pain.

The post-bariatric diet is initiated with liquidised foods and fluids, introducing semi-solids and solids over the ensuing months as they are increasingly tolerated. During the latter half of the first post-operative year as the body starts to tolerate its new patterns of nutritional intake, protein and vitamin deficiencies may begin to present, as their respective stores have become depleted. Deficiencies of fat-soluble vitamins (A, D, E and K) and protein malnutrition are most common. Chronic nutritional anaemia and osteopaenia are also seen. During this catabolic phase, the immune system is suppressed and the patient is at risk of complications, such as infection. If weight loss is successful, some comorbidity, such as back pain can start to improve by the fifth post-operative month.[15] Weight and nutrition should be closely monitored until stability is achieved in the second post-operative year (usually at 18 months post-bariatric surgery). As weight starts to plateau the immunosuppressive effects wane, wound healing capabilities improve and reserve capacity against surgical stress is built up.

To allow preservation of lean muscle mass and facilitate exercise, as part of the patient's healthy lifestyle, the body requires between 70 and 100 g (0.8 g/kg ideal body weight), of protein per day for basic metabolic function. Protein malnutrition presents as brittle nails, hair loss, thrombogenesis and immunosuppression. Plastic surgeons must be conscious of the type of bariatric procedure undertaken and be assured that intake is ideal for wound healing.

Serial biochemical and blood profile screening for anaemia, leucopoenia, clotting abnormalities and nutrient deficiency (iron, zinc, protein and vitamins) are essential. Prompt correction and monitoring allow stabilisation and prophylactic build up of reserves, before plastic surgical intervention can be performed safely. Liver failure is an occult unexplained risk that can present early as well as late in the post-operative period. Unfortunately this can be fulminant and life threatening. Compliance with nutritional supplementation is essential to preventing these complications.

Weight stability, defined, as within 3 kg of median weight over a 6–12 month period, following the initial period of dramatic weight loss is a potentially safe entry criteria for consideration of plastic surgery. A body mass index between 25 and 30 kg/m^2 or 'fully deflated' is the most favourable scenario in which to operate. Those that are active also favour well. Fitness reflects high levels of motivation, as well as implying adequate cardiovascular and/or respiratory reserve.

Unsuccessful weight loss needs additional input from the team dietician, either for counselling or in conjunction with the bariatric surgeon, consideration for a secondary surgical procedure. Significant weight gain during body contouring should also be referred back into the multidisciplinary team as early as possible.

4. Psychological aspects

Obese patients arrive at the bariatric service with many long-term concurrent issues. The clinician must be aware that chronic psychological problems can be exacerbated by weight change and any rapid or unexpected changes in bodily form. If appropriate expectations prior to weight loss surgery have not been set, patients can feel let down. This can manifest as feelings of anger, frustration, an inappropriate 'right' to further treatment and surprising disappointment with successful weight loss or with their resultant appearance. Patients also need to be counselled regarding the possibility of body contouring surgery, before embarking on bariatric surgery. The doctor–patient relationship in this group is complex and long term. It is important to keep the trust of the patient by giving this information early. We have devised a patient information leaflet (see appendix 1).

Pre-operative assessment of psychological stability and comorbid history is essential. Ongoing support and encouragement during the entire massive weight loss program must follow. 66% of patients have been identified as having a lifetime history of a DSM 4, axis one, psychiatric disorder. The most frequent individual lifetime diagnoses are Major depressive disorder (42%) and binge eating disorder (27%).[16] These appear to impact on post-operative quality of life rather than weight loss. 20% have personality disorders. High rates of childhood adversity are also seen with about 20% reporting a history of sexual abuse.[17] Being overweight with the associated stigma is often ingrained in a patient's identity, never more so than when the patient has been an overweight adolescent. Avoidance

behaviour, comfort eating, purging and body dysmorphic elements reinforce each other in a vicious circle of over-eating. Commonly their weight has been blamed for lack of social or professional success and emotional lability. Indeed over 80% have expressed a preference for amputation and blindness over their perceived obesity related disability. It is often difficult to manage this group's level of expectation, as the belief that surgery is the solution to all their problems is a strongly held misconception.

The aim of psychological assessment is to optimise functioning prior to surgery and clarify the expectations for the enforced lifestyle changes. It is sometimes difficult to make screening by a trained psychiatrist or senior psychologist mandatory because of limited resources in the NHS. As surgeons we must identify psychological issues obtained through a detailed history, in conjunction with formal psychiatric reports, as it will be inherent to the success of any procedures undertaken. Barriers to progress include drug and/or alcohol misuse, self-harm, psychoses, dementia, severe mood disorders, marked social adversity, limited insight into eating behaviour, a history of poor adherence to outpatient attendance and moderate/severe learning difficulties (IQ $<$ 50). Informed consent is an essential component of preparation and assessment in view of the impact of expectations on outcome in this group.

The social stigma of bariatric surgery has many facets. In addition to the possible public perception of cheating weight gain, disagreement relating to surgical risk taken in the active pursuit of vanity can cause contention. Moreover, anecdotally, severely obese patients have friends and family members who are more likely to be obese themselves and comparison with these persons can drive feelings of guilt.

Psychiatrists and psychologists have observed several trends in patients who have undergone bariatric and plastic surgery. A bariatric patient is two to five times more likely than the general public to be depressed if their BMI is $>$40 kg/m^2.[18] After weight loss surgery, there are consistent improvements in mood and quality of life (although a small sub group appear to deteriorate and higher rates of suicide are anecdotally seen.) Reintegration with society, improved mobility and greater self-confidence are all hugely beneficial for this group of patients.

However, when weight loss starts to plateau after approximately 9 months, there may be a re-emergence of previous psychological problems. If patients haven't been educated in other methods of coping with stress, dietary modification, or dealing with substance abuse, then these problems can recur (the evidence for addiction substitution here is quite weak and anecdotal within our unit). The greatest concern lies in combating emotional 'comfort' eating along with the pre-occupation with food. It is clear that the relationship between weight and psychological state are closely related. Redundant skin following weight stability can trigger the resurgence of self-disgust, reduced sexual drive, a sense of disappointment and social disengagement. Body image dissatisfaction from excess skin following bariatric surgery is seen in up to 2/3rd of patients.[18]

Peri-operatively it is essential to address the patients' eating behaviour and emotional coping strategy, reach agreement on appropriate expectations, ensure adherence to the follow-up protocols and re-affirm social support from friends. Strategies to prevent relapsing behaviour also include empowering the support network against any identified 'saboteurs'. Generally, patients are satisfied[19] and very grateful for the aesthetic and functional changes seen following body contouring surgery.[20] We should remember that improving body contour does not automatically improve psychological well-being.[21]

These patients need to be handled gently when admitted to hospital. Junior medical and nursing staff should be briefed about this patient group, and innocuous comments avoided. Short and long-term psychological follow-up in a multidisciplinary team setting is therefore essential.

5. Plastic surgical consultation

The overall aim of an integrated weight loss and plastic surgery program is to restore a person back to normality: physiologically, psychologically, physically and socially. Losing weight improves health by reducing associated comorbidities and reducing the risk to life. Changing body image helps self-esteem and confidence. Feeling and looking better helps work productivity and social integration. Plastic surgeons, unlike many other specialists, are traditionally exposed to the aesthetic patient consultation throughout their training. Therefore it is plausible that although the patient's transition to their 'new life' starts some time before bariatric surgery, the psychological and physical sequelae of altered aesthetic form may only be addressed formally in the plastic surgery consult.

From our observational data we can conclude that two main referral pathways to the plastic surgery service exist: Primary care referral following traditional diet/exercise (30%) or weight loss surgery (30%) or tertiary care referral from bariatric surgeons (30%). Less commonly do patients self-refer in the private sector although this is anecdotally increasing.

Looking more closely at the NHS post-bariatric surgery cohort, at the time of the plastic surgery consult, patients have usually had bariatric, psychological and nutritional screening. It would be ideal for patients to present with pre-agreed funding for body contouring procedures as part of their bariatric package of care, so that their journey is more streamlined, but this unfortunately is seldom the case. It is often a struggle to get PCT funding and applications need to be made to individual PCTs via the exceptional circumstances route. Local guidance varies, but is usually designed to exclude many patients and therefore save money.

Surgical intervention is not without its risks. These patients are more likely to have diabetes mellitus, hypertension, left ventricular hypertrophy, deep venous incompetence secondary to deep vein thrombosis or the sequelae of previous pulmonary embolism, to name the commonest. This reduces cardiovascular and respiratory reserve. They may be nutritionally brittle, and have little in reserve for surgical challenge, despite having normal parameters on routine biochemical investigation. Gastrointestinal enquiry should elucidate any symptoms of vomiting, gastric dumping, diarrhoea or steatorrhoea, in addition to weight stability.

Any plastic surgery consultation must thoroughly evaluate the patient's aesthetic 'wish-list' after assessing their physiological, psychological and nutritional state and prior to assessing the anatomical abnormalities capable of correction. This should then be followed by a frank and open discussion on what is possible, achievable and practical so that realistic expectations are set. A number of pre-operative clinic attendances also allow the establishment of rapport, evaluation of weight and psychological stability and pre-operative nutritional screening. Moreover, this gives patients' time and opportunity to undertake their own research and ask questions, allowing expectations to be made, measured and accordingly modified. Our patients typically meet with the plastic surgeon twice and a clinical nurse specialist on an intermediary visit so that all issue and questions are discussed.

Peri-operative photography can help with the pre-operative discussion and act as an *aide memoir* when problems arise. Drawing scar placement on the photographic record can also help the transfer of information and in informed consent. An information leaflet is vital (See appendix 1).

Anaesthetic review with appropriate investigation is necessary to risk assess cardiovascular and respiratory function and reserve, as well as the risks of problems with intubation. A fatty liver

predisposes patients to sudden hepatic failure. Portal venous Doppler scanning and liver biopsy can be useful in distinguishing borderline cases.

6. Anaesthetic risks

Fortunately, the patients referred for consideration of plastic surgery have a much lower average body mass index when compared with the pre-bariatric cohort. Respiratory atelectasis remains a major risk of lengthy procedures. Hospitalisation and immobility after surgery predisposes to thrombo-embolic disease. These patients should be treated as high risk for DVT/PE and have thromboprophylaxis, which increases the already high risks of bleeding.

Brachioplasty, thigh lifts and breast mastopexy procedures are usually short (<2 h each) whilst traditional abdominoplasty (tummy tuck), or a belt lipectomy takes slightly longer (3 h) and an upper or lower body lift can take 4–6 h. Some patients need turning from prone to supine position intra-operatively, and our anaesthetic colleagues like forewarning in these situations. A typical surgical plan may include addressing the lower abdomen, buttocks or circumferential trunk first (an abdominoplasty, belt lipectomy/lower body lift with/without buttock augmentation), coupled with a brachioplasty. Upper body lift, bilateral augmentation, mastopexy and excision of upper back skin folds would be coupled with an inner thigh lift. It would then be possible to complete the plastic surgery within 2 operations, but we usually explain that a third procedure should be expected as touch ups that address minor asymmetries are frequently needed. The surgeon should aim for about 6 h of operating per session. Higher risk individuals may only need simple amputation of excess skin (apronectomy) as opposed to more complex body contouring.

Surgery can total 10–14 h over a 1-year period. Furthermore, although a huge array of surgical options can be undertaken and it is tempting for the surgeon to address all areas of deformity, it is essential to address the patients primary concerns first. This alone may achieve their aims, with little added benefit from any other surgery.

Multiple procedures are often necessary and it is sensible to construct and agree a staged plan of phased interventions with the patient. The surgeon should remember to balance technical goals with patient fitness and the risks and complications of surgery.

7. Surgical risks

The course of surgical events can cause great strain on the body, especially if lengthened by complications. Close consultation with a dietician between surgical interventions is necessary to maximise wound healing. Nutritional deficiencies throughout the healing process should be picked up early and actively corrected.

Post-operative bleeding is the greatest surgical risk. Infiltration with vasoconstrictor and meticulous haemostasis is essential. In the obese patient, blood vessels supplying hypertrophic fatty tissue become larger in calibre. Following weight loss, they remain large and therefore have the potential to bleed more if not properly controlled. Hypertension may compound the problem of blood loss. Laxity within the skin also makes post-operative haematoma more difficult to diagnose, causing delay in return to theatre, and the necessity for blood transfusion.

Thrombotic and antibiotic prophylaxis are essential in all procedures, whilst intra-operative protection of pressure points and hypothermia become more important in longer operations.

Complication rates in body contouring surgery range from 31 to 66%. A recent meta-analysis comparing sixty-five studies and wound healing complication rates were similar to that for cancer (45.8%), burn injuries (30.4%), the post-transplant immunosuppressed (36%), and obese populations (43%).[22] Malnutrition places the patient at greater risk of post-operative wound healing issues and infection. Patients demonstrating aversion to protein rich foods are the worst candidates for surgery, as are the smoking population. Surgery in these groups should be undertaken with caution, and limited in extent. As an example: in a cohort of 48 post-bariatric patients, 38% had low prealbumin (<20 mg/dl), 33% had vitamin A deficiency, 32.6% had low hemoglobin (<12 g/dl), 16.3% had iron deficiency, 9.5% had vitamin B12 deficiency, and 12% had hyperhomocystinemia Comparing these with non-bariatric patients, the deficiencies are far less prevalent (10% had low prealbumin and 11.5% had vitamin A deficiency).[23]

Post-operative seromas are more problematic because of reduced recoil in the adipocutaneous flaps, greater potential space for collection following soft tissue dissections and inevitable injury to lymphatics. These must be serially aspirated in the outpatient's clinic. Fat or skin-edge necrosis is more common because of the wide undermining of the soft tissue flaps, which causes devascularisation, aggravated by the small vessel disease of chronic glucose intolerance. Circumferential surgery can cause distal extremity swelling for months after surgery and all efforts should be made to minimise lymphatic damage (preservation of some superficial fascia or staged intervention for circumferential surgery can aid this). Previous scars can additionally compromise blood supply to flaps throughout the body and meticulous attention to these whilst planning is important.

8. Summary

We believe that a multidisciplinary approach is best. In addition we believe the assistance of trained and skilled clinical nurse specialists who can spend the necessary time with adjunctive aids such as peri-operative photographs and introductions to previous patients are essential for optimum outcomes. The general practitioner is essential to maintain motivation, fire-fight any ad-hoc complications and communicate ongoing social concerns with the hospital-based clinicians. They are also important in controlling the financial purse that pays for such reconstructive (or aesthetic procedures,) depending on ones view.

Centres of excellence are clearly the future for this sub-specialty within plastic surgery, as bespoke facilities, trained staff and time are needed to maximise efficiency, safety and improved outcomes. Large volume work will allow research and expertise to develop with time, along with a well-structured training environment providing an accreditation framework to enable fellows to gain successful qualification.

Conflict of interest

None of the authors have any conflicts of interest.

Appendix. Supplementary data

Supplementary data related to this article can be found online at doi:10.1016/j.ijsu.2010.10.002.

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